## Practice: 527 - Karst Sinkhole Treatment

## Scenario: #1 - Linear Opening

### Scenario Description:

Installing a sinkhole protection cap on a sinkhole with a linear opening. The area around a sinkhole may be unstable and slippage or subsidence may occur. Sinkholes present fall hazards to people and livestock. Sinkholes are direct conduits to groundwater. Nutrient or chemical laden runoff may flow directly into sinkholes polluting groundwater. Sinkholes are routinely used for waste pits by landowners. Critical Area Planting (342), Fence (382), Vertical Drain (630), Obstruction Removal (500) & Filter Strips (393) may be associated practices for this scenario.

### Before Situation:

Open sinkhole poses threat to people, livestock, & wildlife. Absence of buffer allows nutrients and chemicals to flow into the open sinkhole untreated. Trash & Debris have accumulated in the sinkhole from years of use as a waste pit. 'Typical Sinkhole treated is 25' length and 10' top width, depth varies

### After Situation:

Debris removed and properly disposed of off site. The sinkhole protection cap installation resolves the safety issue for people, livestock, & wildlife. The open crevice is filled with porous material so as not to disrupt the hydrology of the karst system while filtering runoff. Typical Sinkhole treated is 25' length and 10' top width, depth varies.

**Scenario Feature Measure:** LF of opening

**Scenario Unit:** Foot

**Scenario Typical Size:** 25

**Scenario Cost:** $9,336.12 **Scenario Cost/Unit:** $373.44

### Cost Details (by category):

| Component Name | ID | Component Description | Unit | Price ($/unit) | Quantity | Cost |
|---|---|---|---|---|---|---|
| ***Equipment/Installation*** | | | | | | |
| Hydraulic Excavator, 1 CY | 931 | Track mounted hydraulic excavator with bucket capacity range of 0.8 to 1.5 CY. Equipment and power unit costs. Labor not included. | Hour | $115.72 | 8 | $925.76 |
| Concrete, CIP, formed reinforced | 38 | Steel reinforced concrete formed and cast-in-placed in formed structures such as walls or suspended slabs by chute placement. Typical strength is 3000 to 4000 psi. Includes materials, labor and equipment to transport, place and finish. | Cubic yard | $505.45 | 6 | $3,032.70 |
| Excavation, Common Earth, side cast, small equipment | 48 | Bulk excavation and side casting of common earth with hydraulic excavator with less than 1 CY capacity. Includes equipment and labor. | Cubic yard | $2.36 | 95 | $224.20 |
| Geotextile, woven | 42 | Woven Geotextile Fabric. Includes materials, equipment and labor | Square Yard | $2.53 | 80 | $202.40 |
| Dozer, 80 HP | 929 | Track mounted Dozer with horsepower range of 60 to 90. Equipment and power unit costs. Labor not included. | Hour | $68.19 | 4 | $272.76 |
| Earthfill, Dumped and Spread | 51 | Earthfill, dumped and spread without compaction effort, includes equipment and labor | Cubic yard | $3.61 | 50 | $180.50 |
| ***Labor*** | | | | | | |
| General Labor | 231 | Labor performed using basic tools such as power tool, shovels, and other tools that do not require extensive training. Ex. pipe layer, herder, concrete placement, materials spreader, flagger, etc. | Hour | $22.22 | 4 | $88.88 |
| Equipment Operators, Heavy | 233 | Includes: Cranes, Hydraulic Excavators >=50 HP, Dozers, Paving Machines, Rock Trenchers, Trenchers >=12”, Dump Trucks, Ag Equipment >=150 HP, Scrapers, Water Wagons. | Hour | $37.38 | 12 | $448.56 |
| ***Materials*** | | | | | | |
| Pipe, PVC, Schedule 80, Perforated | 1408 | Materials: 12" Diameter schedule 80 perforated pvc pipe - ASTM D1785 | Foot | $40.49 | 20 | $809.80 |
| Aggregate, Gravel, Graded | 46 | Gravel, includes materials, equipment and labor to transport and place. Includes washed and unwashed gravel. | Cubic yard | $35.94 | 30 | $1,078.20 |

***Materials***

| | | | | | | |
|---|---|---|---|---|---|---|
| Straw | 1237 | Small grain straw (non organic and certified organic). Includes materials only. | Ton | $118.54 | 10 | $1,185.40 |
| Rock Riprap, graded, angular, material and shipping | 1200 | Graded Rock Riprap for all gradation ranges. Includes materials and delivery only. | Ton | $24.54 | 15 | $368.10 |

***Mobilization***

| | | | | | | |
|---|---|---|---|---|---|---|
| Mobilization, medium equipment | 1139 | Equipment with 70-150 HP or typical weights between 14,000 and 30,000 pounds. | Each | $259.43 | 2 | $518.86 |

## Practice: 527 - Karst Sinkhole Treatment

## Scenario: #2 - Reverse Filter, CY

### Scenario Description:

Closing a cone-shaped sinkhole with stone, gravel and soil from offsite sources in order to maintain existing hydrology. The area around a sinkhole is unstable and slippage or subsidence may occur. Sinkholes present safety hazards to people, equipment and/or livestock. Sinkholes are direct conduits to groundwater, nutrient or chemical laden runoff that enters a sinkhole will pollute groundwater. Sinkholes have routinely been used as waste disposal sites. The sinkhole area and depth is easy to measure to estimate the volume of work to be done. Associated practices: Critical Area Planting (342), Fence (382), Vertical Drain (630), Obstruction Removal (500) & Filter Strips (393) Diversion (362).

### Before Situation:

An open sinkhole exists in an agricultural setting. Open sinkhole poses a risk to people, equipment, livestock, & wildlife. The sinkhole has been used as a waste disposal site and is full of solid waste and debris. Polluted runoff flows into the open sinkhole untreated. Typical Sinkhole treated is cone-shaped, with a 30' Diameter opening & 8' depth.

### After Situation:

Solid waste, if present, is addressed under associated practice Obstruction Removal (500). Organic debris and soil are excavated and utilized or disposed on-site. The sinkhole closure consists of locating the throat, plugging the throat, and placing layers of graded aggregate. A few boulders are placed to bridge the throat, followed by layers of progressively smaller material from rip-rap to sand. Porous material is used to filter runoff and maintain the hydrology of the karst system. Geotextile spans the opening to separate material and distribute loads. Native soil is spread and graded to blend with original ground. A buffer may be established around the sinkhole through associated practice Critical area planting (342).

**Scenario Feature Measure:** CY of sinkhole

**Scenario Unit:** Cubic Yard

**Scenario Typical Size:** 75

**Scenario Cost:** $9,713.78 **Scenario Cost/Unit:** $129.52

### Cost Details (by category):

| Component Name | ID | Component Description | Unit | Price ($/unit) | Quantity | Cost |
|---|---|---|---|---|---|---|
| ***Equipment/Installation*** | | | | | | |
| Earthfill, Dumped and Spread | 51 | Earthfill, dumped and spread without compaction effort, includes equipment and labor | Cubic yard | $3.61 | 110 | $397.10 |
| Geotextile, woven | 42 | Woven Geotextile Fabric. Includes materials, equipment and labor | Square Yard | $2.53 | 220 | $556.60 |
| Excavation, Common Earth, side cast, small equipment | 48 | Bulk excavation and side casting of common earth with hydraulic excavator with less than 1 CY capacity. Includes equipment and labor. | Cubic yard | $2.36 | 75 | $177.00 |
| Dozer, 80 HP | 929 | Track mounted Dozer with horsepower range of 60 to 90. Equipment and power unit costs. Labor not included. | Hour | $68.19 | 16 | $1,091.04 |
| Hydraulic Excavator, 2 CY | 932 | Track mounted hydraulic excavator with bucket capacity range of 1.5 to 2.5 CY. Equipment and power unit costs. Labor not included. | Hour | $193.45 | 16 | $3,095.20 |
| ***Labor*** | | | | | | |
| General Labor | 231 | Labor performed using basic tools such as power tool, shovels, and other tools that do not require extensive training. Ex. pipe layer, herder, concrete placement, materials spreader, flagger, etc. | Hour | $22.22 | 16 | $355.52 |
| Equipment Operators, Heavy | 233 | Includes: Cranes, Hydraulic Excavators >=50 HP, Dozers, Paving Machines, Rock Trenchers, Trenchers >=12", Dump Trucks, Ag Equipment >=150 HP, Scrapers, Water Wagons. | Hour | $37.38 | 32 | $1,196.16 |
| ***Materials*** | | | | | | |
| Rock Riprap, graded, angular, material and shipping | 1200 | Graded Rock Riprap for all gradation ranges. Includes materials and delivery only. | Ton | $24.54 | 18 | $441.72 |
| Aggregate, Gravel, Graded | 46 | Gravel, includes materials, equipment and labor to transport and place. Includes washed and unwashed gravel. | Cubic yard | $35.94 | 38 | $1,365.72 |
| ***Mobilization*** | | | | | | |

***Mobilization***

| | | | | | | |
|---|---|---|---|---|---|---|
| Mobilization, medium equipment | 1139 | Equipment with 70-150 HP or typical weights between 14,000 and 30,000 pounds. | Each | $259.43 | 2 | $518.86 |
| Mobilization, medium equipment | 1139 | Equipment with 70-150 HP or typical weights between 14,000 and 30,000 pounds. | Each | $259.43 | 2 | $518.86 |

## Practice: 527 - Karst Sinkhole Treatment

## Scenario: #3 - Reverse Filter, SF

### Scenario Description:

Installing a sinkhole protection cap on a sinkhole with a vertical opening. The area around a sinkhole may be unstable and slippage or subsidence may occur. Sinkholes present fall hazards to people and livestock. Sinkholes are direct conduits to groundwater. Nutrient or chemical laden runoff may flow directly into sinkholes polluting groundwater. Sinkholes are routinely used for waste pits by landowners. The sinkhole surface area is easily determined, but the depth is not defined making a volume determination difficult, therefore use the surface area as the payment unit. This option to solve situation includes removing any debris, removing unconsolidated soil down to bedrock, installing geotextile, large rock and progressively smaller rock, wrap with geotextile to make a reverse filter and capping with impervious material if site is not a low area. Naturally low areas will be finished to allow perculation without causing fines to move out with associated practice, Vertical Drain.

Associated Practices: Critical Area Planting (342), Fence (382), Vertical Drain (630), Obstruction Removal (500) & Filter Strips (393) may be associated practices for this scenario.

### Before Situation:

Open sinkhole poses threat to people, livestock, & wildlife. Absence of buffer allows nutrients and chemicals to flow into the open sinkhole untreated. Trash & Debris have accumulated in the sinkhole from years of use as a waste pit. Typical Sinkhole treated is 30' Dia & 8' depth

### After Situation:

Debris removed and properly disposed of off site. The 30' diameter by 8' deep sinkhole was then excavated and layers of geotextile and stone placed to establish a reverse filter and then topped with a protective cap of soil to resolve the safety issue for people, livestock, & wildlife. SItes with sinkholes in low areas will need a vertical drain too allow drainage and planned as a seperate practice.

**Scenario Feature Measure:** Surface area of sinkhole

**Scenario Unit:** Square Foot

**Scenario Typical Size:** 706

**Scenario Cost:** $6,453.24 **Scenario Cost/Unit:** $9.14

### Cost Details (by category):

| Component Name | ID | Component Description | Unit | Price ($/unit) | Quantity | Cost |
|---|---|---|---|---|---|---|
| ***Equipment/Installation*** | | | | | | |
| Hydraulic Excavator, 1 CY | 931 | Track mounted hydraulic excavator with bucket capacity range of 0.8 to 1.5 CY. Equipment and power unit costs. Labor not included. | Hour | $115.72 | 8 | $925.76 |
| Geotextile, woven | 42 | Woven Geotextile Fabric. Includes materials, equipment and labor | Square Yard | $2.53 | 220 | $556.60 |
| Earthfill, Dumped and Spread | 51 | Earthfill, dumped and spread without compaction effort, includes equipment and labor | Cubic yard | $3.61 | 70 | $252.70 |
| Hydraulic Excavator, 1 CY | 931 | Track mounted hydraulic excavator with bucket capacity range of 0.8 to 1.5 CY. Equipment and power unit costs. Labor not included. | Hour | $115.72 | 8 | $925.76 |
| ***Labor*** | | | | | | |
| Equipment Operators, Heavy | 233 | Includes: Cranes, Hydraulic Excavators >=50 HP, Dozers, Paving Machines, Rock Trenchers, Trenchers >=12", Dump Trucks, Ag Equipment >=150 HP, Scrapers, Water Wagons. | Hour | $37.38 | 8 | $299.04 |
| General Labor | 231 | Labor performed using basic tools such as power tool, shovels, and other tools that do not require extensive training. Ex. pipe layer, herder, concrete placement, materials spreader, flagger, etc. | Hour | $22.22 | 10 | $222.20 |
| ***Materials*** | | | | | | |
| Rock Riprap, graded, angular, material and shipping | 1200 | Graded Rock Riprap for all gradation ranges. Includes materials and delivery only. | Ton | $24.54 | 36 | $883.44 |
| Aggregate, Gravel, Graded | 46 | Gravel, includes materials, equipment and labor to transport and place. Includes washed and unwashed gravel. | Cubic yard | $35.94 | 52 | $1,868.88 |
| ***Mobilization*** | | | | | | |
| Mobilization, medium equipment | 1139 | Equipment with 70-150 HP or typical weights between 14,000 and 30,000 pounds. | Each | $259.43 | 2 | $518.86 |

**Practice: 527 - Karst Sinkhole Treatment**

**Scenario: #4 - Circular Opening, Grouted**

## Scenario Description:

Closing a cylindrical sinkhole with grout to exclude runoff from system. The area around a sinkhole is unstable and slippage or subsidence may occur. Sinkholes present safety hazards to people, equipment and/or livestock. Sinkholes are direct conduits to groundwater, nutrient or chemical laden runoff that enters a sinkhole will pollute groundwater. Associated practices: Critical Area Planting (342), Fence (382), Vertical Drain (630), Obstruction Removal (500) & Filter Strips (393) Diversion (362).

## Before Situation:

An open sinkhole exists in an agricultural setting. Open sinkhole poses a risk to people, equipment, livestock, & wildlife. The sinkhole has recently developed following a storm event. Polluted runoff flows into the open sinkhole untreated. Typical sinkhole treated is cylindrical, with a 5' diameter and 20' depth.

## After Situation:

In this setting it is critical to disconnect the surface hydrology from the karst hydrology. Organic debris and soil are excavated and utilized or disposed on-site. The sinkhole closure consists of locating the throat, plugging the throat, and pumping grout to fill the void. A few boulders are placed to bridge the throat. Grout / flowable fill is pumped into the void until refusal. Native soil is spread and mounded over the sinkhole area to shed runoff.

**Scenario Feature Measure:** CY of sinkhole

**Scenario Unit:** Cubic Yard

**Scenario Typical Size:** 15

**Scenario Cost:** $10,458.86 **Scenario Cost/Unit:** $697.26

## Cost Details (by category):

| Component Name | ID | Component Description | Unit | Price ($/unit) | Quantity | Cost |
|---|---|---|---|---|---|---|
| ***Equipment/Installation*** | | | | | | |
| Hydraulic Excavator, 1 CY | 931 | Track mounted hydraulic excavator with bucket capacity range of 0.8 to 1.5 CY. Equipment and power unit costs. Labor not included. | Hour | $115.72 | 8 | $925.76 |
| Concrete, CIP, formed reinforced | 38 | Steel reinforced concrete formed and cast-in-placed in formed structures such as walls or suspended slabs by chute placement. Typical strength is 3000 to 4000 psi. Includes materials, labor and equipment to transport, place and finish. | Cubic yard | $505.45 | 14 | $7,076.30 |
| Excavation, Common Earth, side cast, small equipment | 48 | Bulk excavation and side casting of common earth with hydraulic excavator with less than 1 CY capacity. Includes equipment and labor. | Cubic yard | $2.36 | 7 | $16.52 |
| Hydraulic Excavator, 1 CY | 931 | Track mounted hydraulic excavator with bucket capacity range of 0.8 to 1.5 CY. Equipment and power unit costs. Labor not included. | Hour | $115.72 | 8 | $925.76 |
| ***Labor*** | | | | | | |
| Equipment Operators, Heavy | 233 | Includes: Cranes, Hydraulic Excavators >=50 HP, Dozers, Paving Machines, Rock Trenchers, Trenchers >=12", Dump Trucks, Ag Equipment >=150 HP, Scrapers, Water Wagons. | Hour | $37.38 | 8 | $299.04 |
| General Labor | 231 | Labor performed using basic tools such as power tool, shovels, and other tools that do not require extensive training. Ex. pipe layer, herder, concrete placement, materials spreader, flagger, etc. | Hour | $22.22 | 8 | $177.76 |
| ***Mobilization*** | | | | | | |
| Mobilization, medium equipment | 1139 | Equipment with 70-150 HP or typical weights between 14,000 and 30,000 pounds. | Each | $259.43 | 2 | $518.86 |
| Mobilization, medium equipment | 1139 | Equipment with 70-150 HP or typical weights between 14,000 and 30,000 pounds. | Each | $259.43 | 2 | $518.86 |